DAM DECOMMISSIONING WORKSHOP:
OPTIONS, OPPORTUNITIES AND CHALLENGES

Northwestern Michigan College - Great Lakes Campus, Hagerty Center
Traverse City, Michigan

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Dam Decommissioning: Hydrology and Hydraulics

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US Army Corps of Engineers

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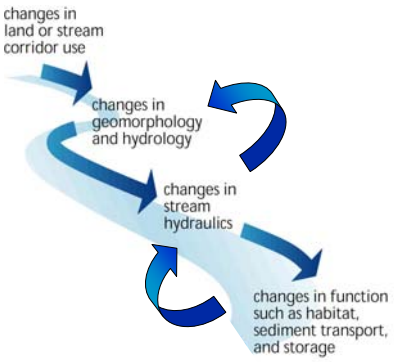
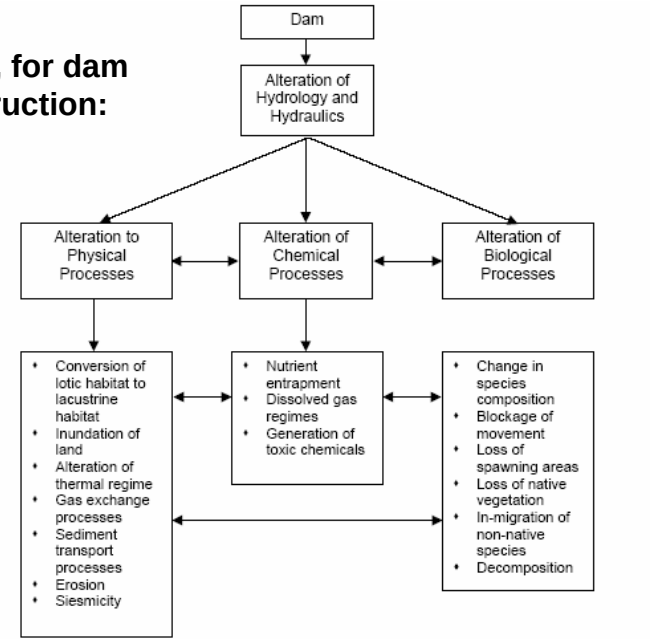
Dam Decommissioning: Hydraulics and Hydrology

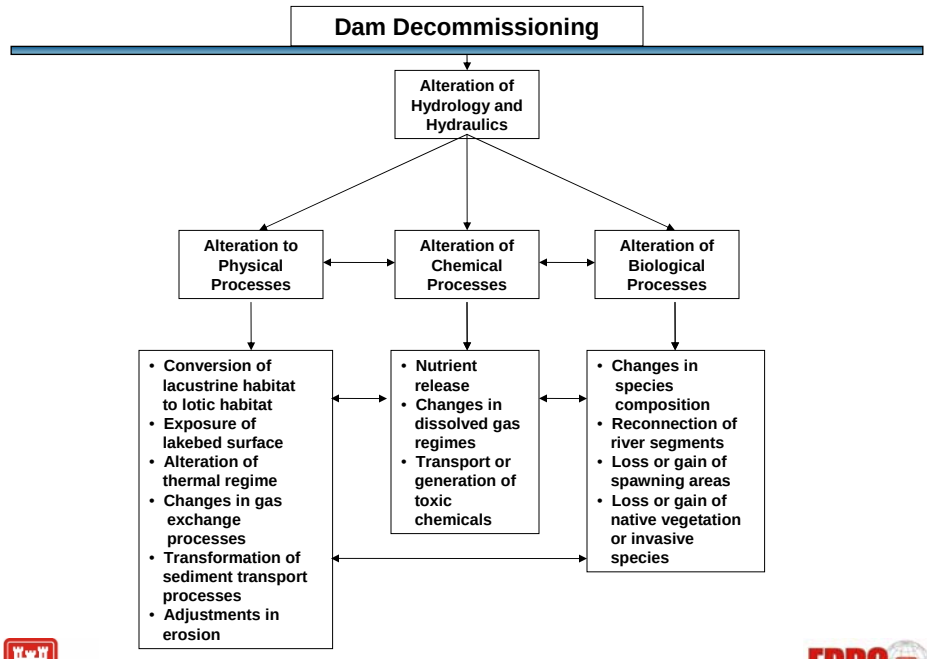
- **Review**
  - **Watersheds reach some equilibrium after dam construction**
  - **Further adjustments due to disturbances associated with dam decommissioning must be considered**
  - **Dam construction impacts provide a useful analog, even though removal is not the opposite of dam construction: some processes are reversible, others are not**



Review, for dam construction:

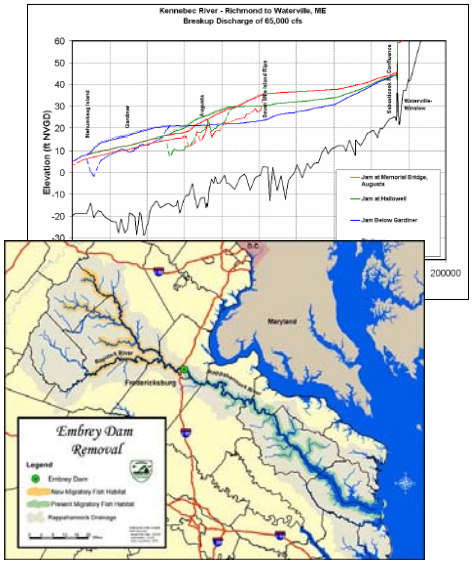


From Bizer, J.R. (2000) "International Mechanisms for Avoiding, Mitigating and Compensating the Impacts of Large Dams on Aquatic and Related Ecosystems and Species."IN Berkamp, G., McCartney, M., Dugan, P., McNeely, J., Acreman, M. (2000) Dams, ecosystem functions and environmental restoration, Thematic Review II.1 prepared as an input to the World Commission on Dams, Cape Town, South Africa: http://www.dams.org



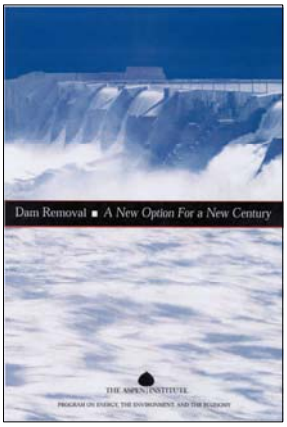
Heinz Center 2002 Workshop on Dam Removal Research

- Hydrologic and hydraulic modeling techniques well-established
  - Need better integration with geomorphologic and biological models
  - Spatially and temporally varying models
- Small dam (<25 ft, run-of-river) removal impacts fairly well-known on site-specific basis
  - Generalization is next step
  - Landscape-scale studies of watershed impact necessary
  - Large dam impacts not well-documented
- General direction of changes predictable, but not magnitude
  - Except for hydrology for small run-of-river dams or where basin hydrology is well-understood



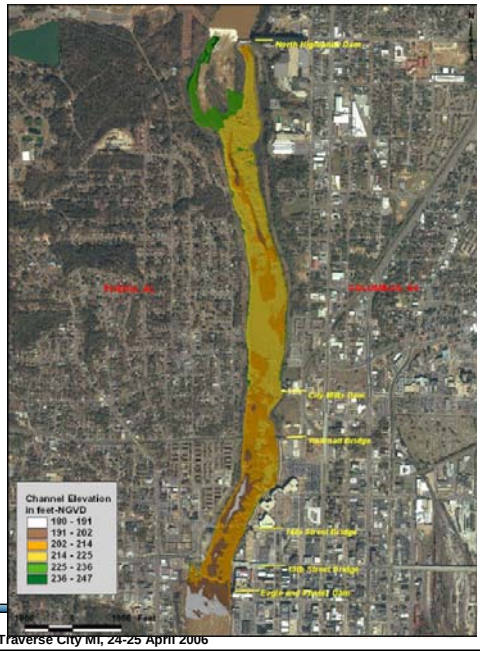
Aspen Institute Forum on Dam Removal

- Flood control alternatives need to be explored if existing dam provides flood attenuation
  - Examine existing flood insurance studies and emergency action plans and evaluate whether restudy is necessary
  - Identify infrastructure upstream and downstream from dam where mitigation is required prior to dam removal
  - Include all areas of potential impact in permit applications



Hydrologic and Hydraulic Data[1]

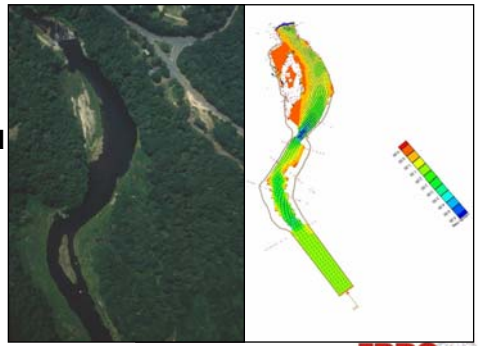
- Watershed/drainage area
- Rainfall data/records and location
- Stream gage records and location
- Geomorphology
- Reservoir/river cross-sections
- Estimates of roughness coefficients
- Flood insurance status
- Dam hazard classification
- Emergency action plans
- Published/unpublished flood reports
- Locations/status of nearby dams



[1] Adapted from ASCE 1997

Hydrologic and Hydraulic Data[1]

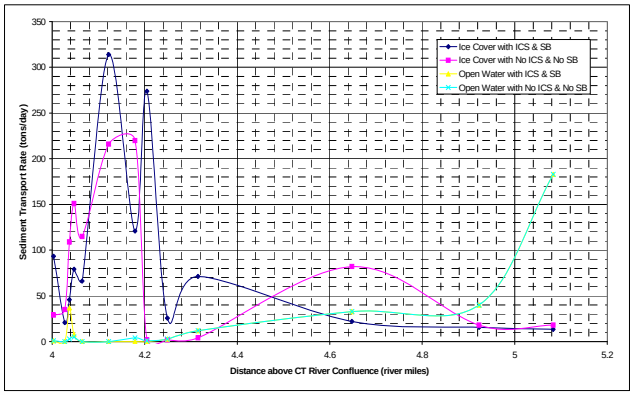
- Historical high water marks and flood profiles
- Ice regime
- Hydraulic models (e.g., HEC-1, HEC-2, HEC-RAS)
- Profiles of river, reservoir, groundwater
- Flood frequency profiles(10-, 50-, 100-, 500-yr, etc.)
- Reservoir operating rule/guide curves
- Inflow hydrograph/design flood
- Reservoir storage capacity
- Flood control capability
- Downstream flood control infrastructure
- Existing groundwater elevations
- Water supply/hydropower users
- Inventory of well logs
- Survey of groundwater users
- River and aquifer flow regimes
- River/aquifer chemical analyses



[1] Adapted from ASCE 1997

Hydrologic and Hydraulic Data[1]

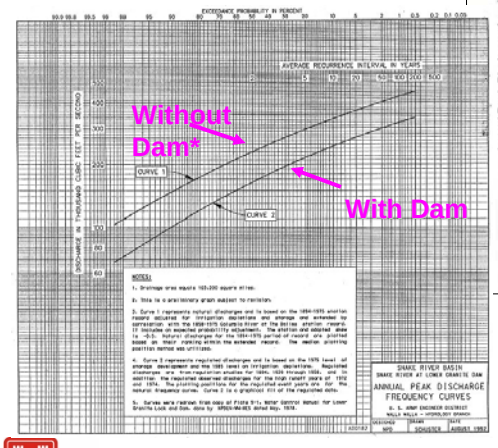
- Exposed water surface area
- Water temperatures
- River suspended sediment
- Identification of existing wetlands
- Characterization of riparian areas
- Bed/Bank sediment characterization
- Reservoir width
- Width of the active channel
- Sediment, sediment, sediment!

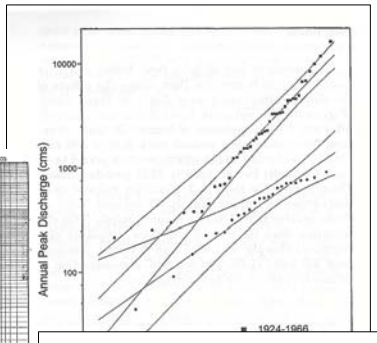


[1] Adapted from ASCE 1997

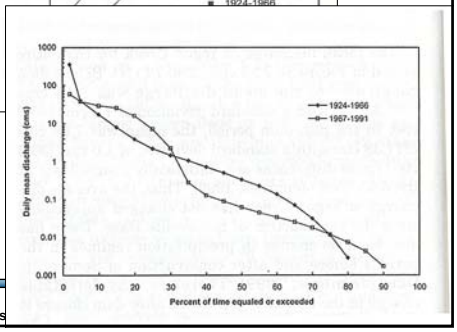
Basic Hydrological Changes from Dam Construction

- Flood frequency
- Flow duration



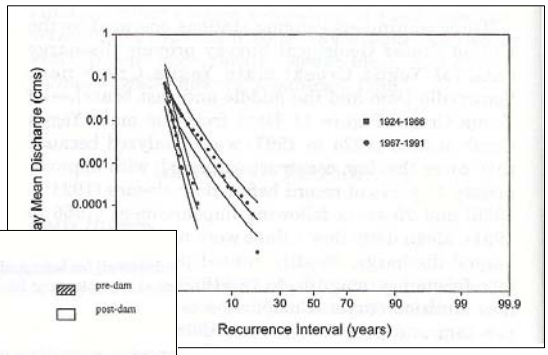


From Chin et al (2002) "Adjustment of stream channel capacity following dam closure, Yegua Creek, Texas." J. A.W.R.A Vol. 38, No. 6, p. 1521-1531.



Hydrologic Differences with Habitat Implications

- **Low-flow frequency**
- **Flood duration**



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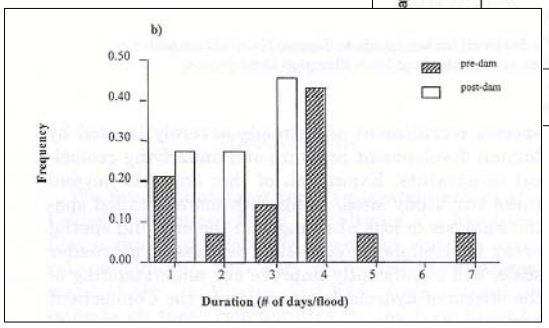
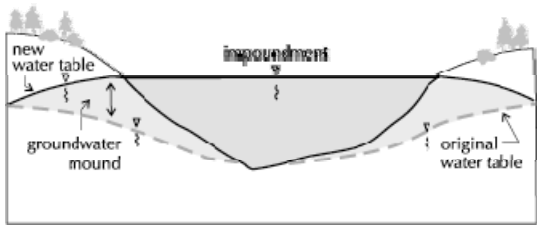
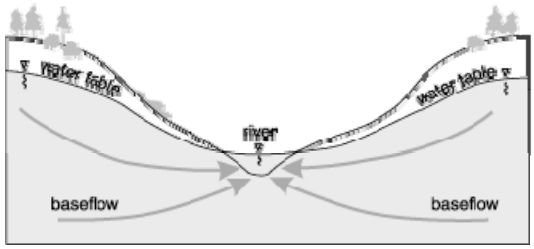


From Nislow et al (2002) "Effects of Dam Impoundment on the Flood Regime of Natural Floodplain Communities in the Upper Connecticut River." J. A.W.R.A Vol. 38, No. 6, p. 1533.

Groundwater

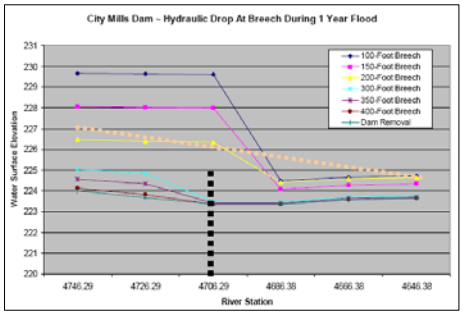


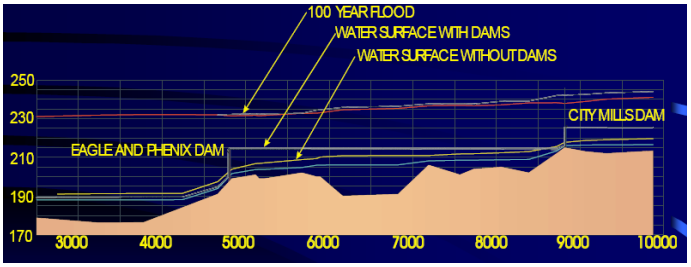


From: University of Wisconsin Water Resources Management Practicum (2000) Dam Repair or Removal: A Decision-Making Guide. http://www.ies.wisc.edu/research/wrm00/index.htm.

Hydraulics Through Dam Site

- **Model hydraulics with and without dams in a variety of situations as part of the alternatives analysis**
  - **Water surface elevations**
  - **velocities**





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Dam Decommissioning Workshop, Traverse City MI, 24-25 April 2006

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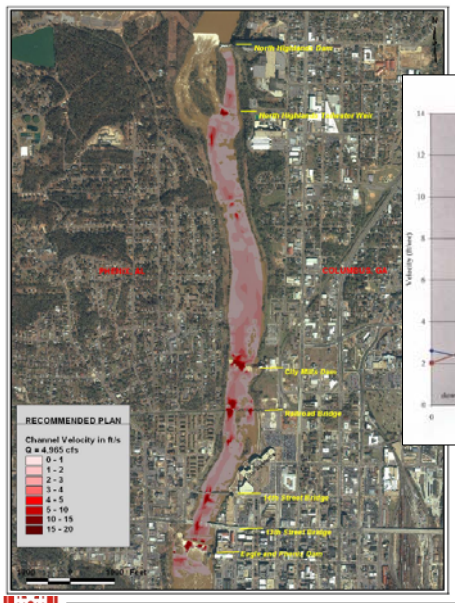
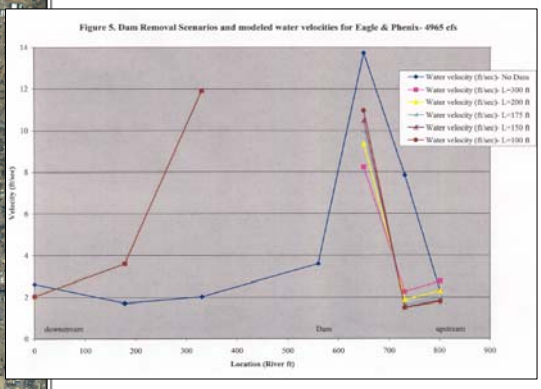
Visualization of Water Velocities





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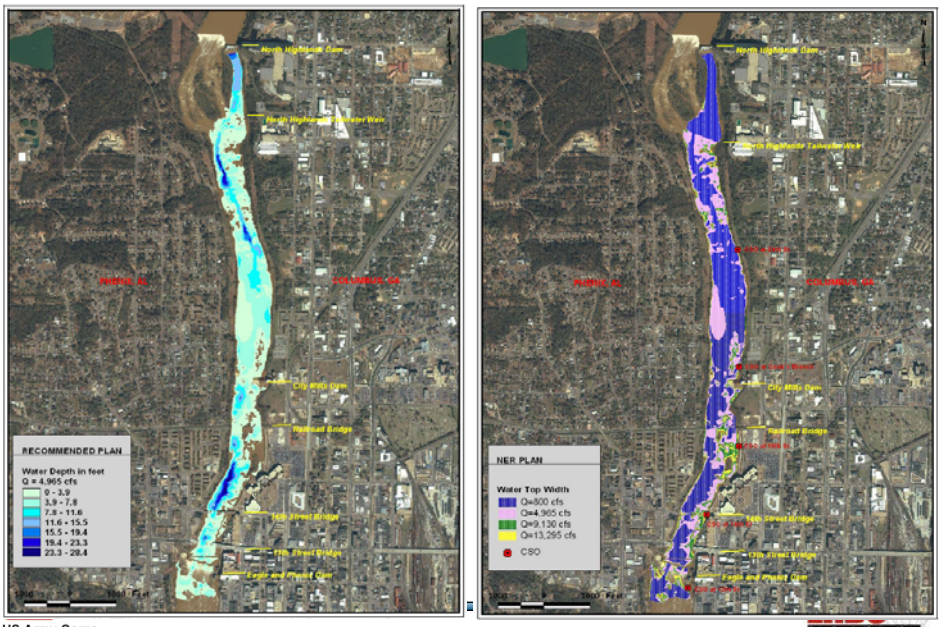
Water Depth and Water Quality Considerations



Reoperations

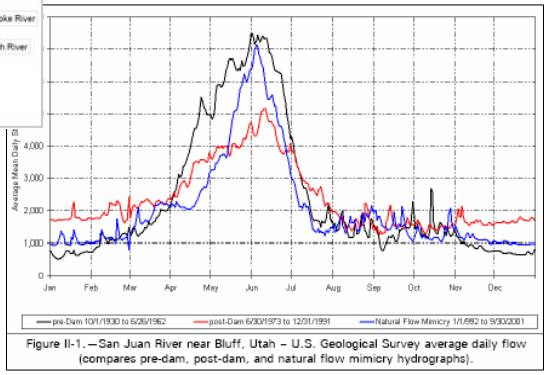


Figure II-1.—San Juan River near Bluff, Utah – U.S. Geological Survey average daily flow (compares pre-dam, post-dam, and natural flow mimicry hydrographs).

From US Department of the Interior Bureau of Reclamation (2002) "Draft Environmental Impact Statement: Navajo Reservoir Operations Navajo Unit – San Juan River, New Mexico, Colorado, Utah." Volume I. http://www.usbr.gov/uc/library/envdocs/eis/navajo/pdfs/deis.pdf

Summary

- **H&H is a fundamental aspect of dam decommissioning**
  - **Floods**
  - **Droughts**
  - **Normal flow**
  - **Flow Duration**
  - **Velocities**
  - **Depth**
  - **Groundwater**

- **Geospatial H&H modeling techniques**
  - **Improve our understanding of river hydraulics under different decommissioning alternatives and resulting impacts on environment**
  - **Visualization is important in aesthetic, cultural, and other socio-economic considerations**